REPORT OF AN INTERNATIONAL MORTALITY STANDARD, OR MORTALITY INDEX.

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1. *Disturbing Influence of Unequal Age Distribution on the Mortality Coefficient.*

The most correct standard of mortality is furnished by life tables, but on account of their intricacy they are seldom compiled. For ordinary statistical purposes the "death rate," although known to be inaccurate, is the usual measure of mortality; and every day we find, not only in newspapers, but also in scientific works, international comparisons of mortality based on these death rates.

The purpose of this paper is to determine whether it is possible to eliminate the errors connected with the usual calculation of the death rate, and thus to arrive at more reliable results.

The death rate gives the number of deaths among a certain number of inhabitants during the year.

Assuming that there occur 6000 deaths during a week in a country having ten millions of inhabitants, this would give for a year 312,000 deaths, and the death rate would be 31.2 per thousand inhabitants. If during another year, or in another country, this rate should rise to 40 per 1000, it would be generally assumed that the mortality had risen, and that by about one-third, the death rate being made use of to measure the sanitary conditions. This quality of the death rate could not be contested without denying all value to this standard. Wherefore establish a measure of mortality which is unable to measure it? But, although the same sanitary conditions exist in two localities, yet the death rate may be different. Take, for instance, two towns with 10,000 inhabitants each, A and B. If 10 per cent of the children and one per cent of the adults died in each of these towns during a

year, the sanitary conditions are the same in both places. And yet the death rate will differ as the number of children and adults differs, or, in other words, it will differ in accordance with the *distribution of ages.*

For instance, if A had 5000 children and 5000 adults, and B 2000 children and 8000 adults, the respective numbers of deaths would be as follows: —

	Children. Mortality 10 Per Cent.	Adults. Mortality 1 Per Cent.	Total.	
In A	500	50	550	55 per cent.
In B	200	80	280	28 " "

It will therefore be seen that the death rate not only depends upon the qualitative (sanitary) conditions of a country, which are the exclusively relevant ones, but is also influenced by a merely quantitative and thus quite irrelevant factor, that is, by the number of the more or less death-resisting elements. For it is evident that more children may be expected to die in a town in which their number is greater than in another* in which it is less, and that we therefore commit an error by confounding the frequency of deceased children with the greater vital danger of childhood.

2. *How to Eliminate the Influence of Unequal Age Distribution. (Standard Population.)*

If we take into consideration two towns with equal numbers of inhabitants, but differing in the number of children, it will at once be evident that in order to arrive at a correct estimate of the respective mortality in these towns the number of deaths, that is, the rough death rate, cannot be taken into consideration, but that we have to ask how this death rate would work out if the number of children had been the same in both. Common sense already tells us that a large number of children in a community points to a great vitality in its inhabitants, and that therefore if the death rate, as

* See page 305 of my Report at the Vienna session of this Institute, *Bulletin,* v. VI, Part 2.

shown in the case of A and B, gives a reverse result, this is irrational.

To arrive, therefore, at correct statistical results it is necessary to compare not the rough death rate of the total populations, but the special death rates of the various age classes. But in statistics it is necessary to represent the mortality of a whole country in *one* figure. It is not enough for us to know that in Paris, for instance, the mortality of children under one year of age is less than in London, that the mortality of children up to five years of age is greater, and that the age classes from 10 to 15 years are equally endangered in both cities, whilst the advancing classes of age present always differing relations. Such propositions, which partly contradict and neutralize one another, do not give us the desired information relative to the vitality of the total populations of these two cities, information which we justly expect from statistics.

At the last session of the International Statistical Institute I recommended a new method of calculation, which eliminates the influence of the various age classes by calculating the mortality within the several classes of age, but on the supposition that the age distribution in the localities to be compared was the same. Thus, the age distribution of A may serve as a basis (standard) for B, or *vice versa;* but we may even choose the distribution of a third locality, or the average distribution of the whole of Europe, as the standard distribution. This is the principal point in my proposal; the age classes to be chosen is a secondary consideration, and will be dealt with later on.

By a strange coincidence this same idea was brought before the session at the same time by Dr. Ogle, the eminent statistician of the English Registration Office. But on account of the novelty of the idea of a Standard Population, the Institute came to no decision, and resolved that a further report on the subject should be rendered at the next convention at Chicago. Only some time after the Vienna session it came

to my knowledge that Dr. Ogle had already perceived and applied the Standard Distribution in 1883,* and I am therefore bound and willing to acknowledge his priority, and will content myself with supporting his idea, and adding a few independent observations.†

3. *Calculation of Mortality Indices.*

I recommend that the death rate of the various age classes (the number of which will be discussed later on) be multiplied by the number of persons belonging to those age classes in the Standard Population, or, better still, by the figure representing the percentage of these age classes. This process produces new values, which I call Age Indices, in order to distinguish them from the Age Coefficient (death rate).

The age indices have this advantage over the coefficients, that they can be added. The sum of the age indices gives the general Mortality Index, which is uninfluenced by the varying distribution of age groups.

Let us assume that it was found desirable to distinguish the following 12 age classes, the percentage of which in the population selected as a standard (Sweden) was as follows: —

0 to 1 years, . . .	2.65 per cent.	10 to 20 years, . . .	19.54 per cent.
1 to 2 " . . .	2.49 "	20 to 30 " . . .	15.63 "
2 to 3 " . . .	2.49 "	30 to 40 " . . .	12.26 "
3 to 4 " . . .	2.32 "	40 to 50 " . . .	10.73 "
4 to 5 " . . .	2.35 "	50 to 60 " . . .	9.32 "
5 to 10 " . . .	10.62 "	Over 60 " . . .	9.60 "
		Total of Standard Population, . . .	100.00 per cent.

Now to apply these ratios to Austria (1881) the following calculations would be necessary: —

1. Calculate the special death rate for each of the 12 age classes.

* Dr. Koch, the Director of the Statistical Office in Hamburg, informs me that as far back as 1883 he had also used the standard calculation, as can be seen on page 44 of the 12th part of the *Statistik des Hamburgischen Staates*. It gives us satisfaction to see that the reasons which our esteemed colleague adduced ten years ago for the necessity of a standard distribution agree almost word for word with ours.

† See also my first paper in the *Bulletin*, Vol. VI. chap. 2.

2. Apply these 12 death rates to the respective figures of the age classes of the standard population, which will produce 12 age indices.

3. By adding the age indices you obtain the general Mortality Index.

a. CALCULATION OF DEATH RATES FOR 12 AGE CLASSES.

Age.	Living on Dec. 31, 1880.	Died, 1881.	Death Rate. Per Cent.
0 to 1	679,458	208,357	306.7
1 to 2	588,521	52,635	89.4
2 to 3	561,479	27,640	49.2
3 to 4	542,773	18,267	33.7
4 to 5	542,599	14,466	26.7
0 to 5	2,914,830	321,365	110.3
5 to 10	2,421,696	30,664	12.7
10 to 20	4,277,867	25,901	6.1
20 to 30	3,588,816	32,610	9.1
30 to 40	2,969,307	34,772	11.7
40 to 50	2,450,404	41,336	16.9
50 to 60	1,838,486	52,381	28.5
Over 60	1,682,838	137,266	81.6
Unknown	.....	220	.....
Total,	22,144,244	676,515	30.6

b. CALCULATION OF MORTALITY INDEX BASED ON THE ASSUMED NORMAL DISTRIBUTION OF AGE CLASSES.

Age Class.	Death Rate.	Standard Distribution.	Died. Per Cent.
0 to 1	306.7	2.65	8.13
1 to 2	89.4	2.49	2.23
2 to 3	49.2	2.49	1.23
3 to 4	33.7	2.32	0.78
4 to 5	26.7	2.35	0.62
0 to 5	110.3	12.30	13.57
5 to 10	12.7	10.62	1.35
10 to 20	6.1	19.54	1.19
20 to 30	9.1	15.63	1.42
30 to 40	11.7	12.26	1.43
40 to 50	16.9	10.73	1.81
50 to 60	28.5	9.32	2.66
Over 60	81.6	9.60	7.83
Total,	30.6	100.00	31.26

It now only remains to answer the following two questions:

(1) How many age classes should be used, *i.e.*, how many death rates should be calculated?

(2) Which age distribution should be used as a standard?

4. *From what Number of Elements should the Mortality Index be Calculated?*

In my report addressed to the Vienna meeting I gave the results of my endeavors to arrive at the difference in the index caused in several countries by various limitations of the age groups. The first calculation was made for 12 groups, viz., the first five years of life in five groups, 5 to 10 years in one group, and the higher age classes in six groups of 10 years each.

The following simplified methods were then tried:—

The first year was calculated separately, and 2 to 5 years taken as one group; the first five years were taken as one group; the ages from 5 to 20 years formed another group; and, finally, the higher age classes were arranged in five groups of 10 years each, and again in three groups of 20 years each.

From these calculations it was found to be preferable to group the first year separately, but there was no sensible change produced by placing the next 19 years (20 inclusive) in a single second group. In the ages over 20 years no difference in the mortality index was appreciable if for the numerous 10-year groups two larger groups, one comprising the ages from 20 to 50, and the other those over 50, were substituted. Regarding especially the more advanced classes (over 60 years) it was found that, in consequence of their drifting number, they may be unhesitatingly united with the class of 50–60. It is therefore evident that, as the results are almost identical if the above four groups are used, (viz., 0–1, 1–20, 20–50, and above 50 years) instead of 12, the former quicker method should be preferred, especially

when monthly, or even weekly, calculations for several countries or towns have to be made.*

The admissibility of the different age limitations may be judged by the measure in which a change of age groups influences the succession. In the following 14 countries, it will be seen that, taking only four age death rates into consideration, the succession of these countries is almost identical with that resulting from 12 death rates, as shown in the table: —

	(*a*) 12 Death Rates.	(*b*) 4 Death Rates.
Sweden	1	1
Norway	2	2
Denmark	3	3
Scotland	4	4
Belgium	5	5
France	6	7
Netherlands	7	6
Switzerland	8	8
Prussia	9	9
Wurtemberg	10	10
Saxony	11	11
Bavaria	12	13
Italy	13	12
Austria (Cisleithania)	14	14

Thus the easiest calculation (that with four elements) did not cause more than two displacements, and even these of only one degree each.†

Dr. Ogle proposes an age distribution of 12 groups, subdivided according to sex, which would require 24 calculations. This increase of labor could only be justified if the result differed materially from that obtained by the simpler and quicker method. But such not being the case, and the

* The *International Weekly Bulletin*, edited by Dr. Janssens (Brussels), gives 250 towns. The usual calculation of one death rate for each town would require 250 calculations per week, and 6250 per annum. The introduction of a mortality index derived from four elements would quadruple the number of operations, and bring them to 25,800, whilst the introduction of 12 age classes would bring the number up to 75,000. Should Dr. Ogle's plan of separating the classes into two sex classes be adopted, the number of calculations required would rise to 150,000, which would hardly be feasible.

† In order to prove the sufficiency of the easiest method (with four elements), let us take the index of Sweden as 100; I will at the same time refer to the amendment proposed by Dr. Bertillon in the Committee of the Vienna Conference (*Bulletin*, Vol. VI, Part 1, page 36). He agreed to the index calculation in principle, and also accepted the above mentioned four age groups, but proposed that, on account of the greater mortality in the highest age classes, a fifth should be added for those over 60 years of age. This proposition ought to be respected, in case that the establishment of a fifth group influences the result; if

difference of the mortality of the two sexes being not great enough to compensate for the heavy increase of labor, I hope Dr. Ogle will qualify his recommendation, at least for cases in which it is essential to arrive quickly at a fairly reliable result.

5. *Use of the Standard Distribution for other Purposes.*

It must be mentioned that Dr. Ogle goes further than I in the application of the standard distribution, as he uses it not only for the calculation of the mortality index, but also for that of births and marriages.

Although these points are beyond the scope of my paper, which only pretends to deal with the death rate, yet in connection with the above I may be allowed to offer some brief remarks upon this topic. The distribution of ages is of im-

not, we ought to prefer the easier method. In order to show the working of this amendment, I give below a table from which will be seen the difference resulting from Dr. Bertillon's amendment. (See my paper in the *Bulletin*, page 305r, lib. C.)

MORTALITY INDEX OF 14 COUNTRIES, TAKING THAT OF SWEDEN AS 100.

	(*a*) 12 Death Rate.	(*b*) 4 Death Rate.	(*c*) Bertillon. (5 Death Rate.)	Difference Between *b* and *c*.
Sweden	100 (1)	100 (1)	100 (1)	0.0 per cent.
Norway	108 (2)	108 (2)	108 (2)	0.0 "
Denmark	114 (3)	116 (3)	115 (3)	0.9 "
Scotland	115 (4)	116 (4)	115 (4)	0.9 "
Belgium	120 (5)	121 (5)	119 (5)	1.7 "
France	127 (6)	130 (6)	129 (7)	0.8 "
Netherlands	130 (7)	130 (7)	127 (6)	2.3 "
Switzerland	131 (8)	130 (8)	131 (8)	0.8 "
Prussia	144 (9)	144 (9)	143 (9)	0.7 "
Wurtemberg	151 (10)	153 (10)	151 (10)	1.3 "
Saxony	158 (11)	157 (11)	159 (13)	1.3 "
Bavaria	158 (12)	159 (13)	155 (11)	2.5 "
Italy	160 (13)	158 (12)	158 (12)	0.0 "
Austria	175 (14)	173 (14)	173 (14)	0.0 "

It will be seen that the 4-element calculation only differs from that of the 12-element by about 2 per cent, giving for a country whose mortality index is 30 per cent an index of between 29½ to 30½ per thousand, a difference which is without any importance, if it is the question to establish a quick and easy calculation of a fairly valuable measure of the mortality. It is also seen that the amendment of Dr. Bertillon causes a still weaker influence.

portance not only for the facts already quoted, but for nearly all phenomena of social life. The criminality of a country, for instance, depends also upon the number of those persons who, on account of their age, are able to commit crimes, and the much lamented larger rate of criminality of large cities is caused to a considerable extent by the simple fact that the age classes which contribute to it are more numerous there than in the villages. Similar difficulties present themselves in the statistics of professions, because here also the number of unemployed depends to a certain extent upon the number of infants and aged people. Therefore in almost all statistical calculations the age distribution has lately been taken into account. Thus, Bertillon (Senior) has proposed to calculate the births coefficient not from the total number of inhabitants, but from those at the age of puberty; in criminal statistics the coefficient of criminality is obtained from the number of people of the age classes which can be made accountable for crime, and some of them are even limited to the male or female portion of a population, as in military crimes or abortion.

But it is not possible to make a general rule as to the limitation of age classes in the various statistical problems. This will have to be considered for each case. So, for instance, in calculating the death rate, different age classes will have to be considered than in marriage or birth statistics. Dr. Ogle proposes for these the same standard distribution as for the mortality (0 to 5, to 10, to 15, etc.); but it appears clear that in calculating the marriage and birth rates the classes from 0 to 15 should be omitted, and for the birth rate, those also in the three classes from 65 years upwards. By omitting these six classes, Dr. Ogle's 12 classes will already be reduced to six, and a further reduction appears to me feasible.

6. *Selection of the Standard Population.*

It now remains to select the population whose age distribution shall be selected as a standard.

In my previous paper I have carried out calculations based on two standard distributions, that of Sweden and that of 14 European states, and it was found (see page 305r) that the order in which the mortality indices of the several countries succeed was almost identical in the two series of calculations. It appears advisable to adopt the simpler, *i. e.*, that based on the distribution in *one* country.* This, especially with only

* Dr. Bleicher, Director of the Communal Statistical Office, at Frankfurt a. m., has submitted a very searching critique of the standard and index calculation to the eighth conference of German Communal Statisticians, and, because the index changes as one or another age distribution is used as a standard, he came to the conclusion to adhere to the old death-rate calculation, at any rate not to abandon it altogether. The latter was never intended; no country can, for its own use, do without the mortality coefficient. But it is another question whether the death rate is suitable for international purposes. If it can be proved that the old coefficient furnishes a correct measure of international mortality, and that this measure is not altered by the different age distributions, there is, indeed, no reason for introducing a new method. But if we think that the death rate furnishes no reliable measure of the mortality,—and I venture to say that scientific literature occupies a hostile position towards this measure,—then it follows necessarily that a new method must be adopted, which is free from the faults pointed out. And this is the sole object of the proposition of Dr. Ogle and myself. As to the objection that the modification of the standard ages exercises too great an influence on the measure of mortality, that is a question of facts, which may be easily verified. I refer in this respect to my first paper, where the indices have been calculated on the base of two different standard populations. The one was taken from 4½ millions of inhabitants of Sweden, the other from the different average of 14 European countries with not less than 225 millions of inhabitants. Let us now see how in the two results the succession and the distance of the mortality indices changes. Assuming the mortality of the first country (Sweden) as 100, the others stand in the following order :—

	Standard : (*a*) 223 Millions of the European States.	Standard : (*b*) 4½ Millions of Sweden.	Difference. Per Cent.
Sweden	100 (1)	100 (1)	0.0
Norway	108 (2)	108 (2)	0.0
Scotland	116 (3)	116 (3)	0.0
Denmark	117 (4)	116 (4)	0.9
Belgium	121 (5)	121 (5)	0.0
France	131 (6)	130 (6)	0.8
Netherlands	131 (7)	130 (7)	0.8
Switzerland	131 (8)	130 (8)	0.8
Prussia	145 (9)	144 (9)	0.7
Wurtemberg	155 (10)	153 (10)	1.3
Saxony	159 (11)	157 (11)	1.3
Italy	159 (12)	158 (12)	0.6
Bavaria	164 (13)	159 (13)	3.0
Austria	174 (14)	173 (14)	0.6

It will be seen (1) that, although the two standards are so vastly different, the order of the countries remained absolutely the same; (2) that the distance of the indices suffered

four age classes, could be calculated in a few minutes, whilst the other — as contained at the pages 305 *a–l* of my paper — represents the work of several days. Further, the census in the several European states is not taken simultaneously, and every statistician would therefore select a different country for his standard, and, unless one of the statistical offices is entrusted with the task of calculating and publishing the table of European standard, a uniformity of coefficients and indices will be impossible.

For these reasons, and on account of the eminent position occupied by Sweden relative to mortality statistics and census of population, I proposed to accept the age distribution of that country as the standard.

7. *Resolutions.*

As Dr. Ogle in his report has only given general indications of the new plan of calculation, without establishing any rules for its use, and as further he has not stated which age distribution should be accepted as the standard, I have to revert to the resolutions formulated in my first paper.

Although from Dr. Ogle's propositions it cannot be seen how far his harmonizes with mine,* yet this is possible by the actual calculations which are found in his other books. In the publications of the English Registration Office our esteemed colleague uses two standard calculations, one in the Annual Reports of that office, and the other in the Annual

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only very slight variations; this distance changed in nine cases scarcely by 1 per cent, remained quite the same in three cases, and was altered only in one case by 3 per cent. The small variations shown above do not warrant the rejection of a theoretically more correct measure of mortality. In face of the approximative value of all measures of mortality there must be finally found a limit beyond which we could not persist in attributing any weight to claims against inaccuracy.

* *Bulletin*, Vol. VI, 1, pages 83 to 85, the proposal of Dr. Ogle is verbatim as follows: "I think it would be highly desirable to select, at any rate for purposes of international statistics, a standard population of fixed age and sex distribution, and to ask the officials in each country, who are charged with the statistics of mortality, to give each year in their reports the death rate for their country as it would have been had the population agreed in its composition with the international standard."

Summaries of Births, Deaths, and Causes of Deaths in London.*

The calculation used in the Annual Report corresponds entirely with that recommended by me. I therefore beg that my propositions should be considered only as amendments to a method which has been used by Dr. Ogle for some time previous to my proposals.

As regards the second method, however, I am sorry to say that I cannot agree with it, and since I have given my reasons more extensively (on pages 305, etc.) of my first paper, I will only here mention that Dr. Ogle's method brings us back again to the death rate, and any difference between the rough and the corrected death rate appearing in his calculations would not be the result of an intentional correction, but of an erroneous average calculation. If we eliminate this error, we are again before the rough death rate, which we intended to correct.

I therefore propose the following resolutions: —

Resolved: 1. In order to obtain a measure of mortality suitable for international purposes, *i. e.*, which will not be influenced by different age distributions in different countries, it is recommended to adopt Dr. Ogle's method, which reduces all age distributions to one standard distribution.

2. In order to obtain a rapid and yet sufficiently reliable result it is sufficient to calculate the death rates for the following four age classes, viz., 0 to 1, 1 to 20, 20 to 50, and upwards of 50.

Recommended: 3. That the age distribution of only one country, for instance, that of Sweden, be adopted as a standard.

4. The new international mortality measure, here called the mortality index, be obtained by multiplying the death rates of the above four age classes by the figures representing the percentage of these age classes in the standard population. The result will be four age indices corresponding with the four age classes, which when added will give the Total Index, or, in other words, the international measure of mortality for the total population.

* The process under consideration is fully given in the Annual Summary for 1883 (quoted verbatim in my Report, on page 305 *y*). A full explanation of this method will also be found in Newsholme's *The Elements of Vital Statistics* (London, 1889).

5. The number of living is, in accordance with existing resolutions, to be calculated yearly on the basis of the difference between the numbers obtained at the two last censuses, and to be taken for the middle of each year. The standard distribution for the ten years elapsing between the general enumerations is to remain unaltered.

EXPERIMENTAL TABLE FOR AUSTRIA (CISLEITHANIA).

Age Group.	Standard Ages (Sweden, 1880).	Death Rate in Austria, 1881.	Mortality Index.
0 to 1	2.65 per cent.	30.67 per cent.	8.13 per cent.
1 to 20	39.81 "	1.90 "	7.56 "
20 to 50	38.62 "	1.20 "	4.63 "
Over 50	18.92 "	5.39 "	10.20 "
Total.	100.00 per cent.	.....	30.52 per cent.